HYDROTHERMAL ALTERATION OF THE IMPACTITES AT THE ICDP DRILL SITE YAX-1 (CHICXULUB CRATER). L. Hecht[1], R.T. Schmitt[1], A. Wittmann[1], [1]Inst. Mineralogy, Nat History Museum, Berlin, 10115, Germany, lutz.hecht@museum.hu-berlin.de

Introduction. About 100 m of impactites (suevite-type breccias) have been drilled at the ICDP drill site Yax-1 within the Chicxulub impact structure (see [1] for more information). Post-impact hydrothermal alteration including alkali metasomatism and devitrification of impact melt glass has significantly modified the mineralogy and chemistry of the impact breccia lithologies. Hydrothermal alteration has also affected the breccia dikes [2] in the cretaceous megablock and locally the host sediments.

Petrography. At least two stages of hydrothermal alteration can be distinguished within and adjacent to the impactites:

Stage 1) The original glassy groundmass of melt components (either matrix or fragments) is hydrated and altered to a submicroscopic mass which most probably consists of clay minerals (e.g. smectites). Preliminary microprobe analysis indicate that it mainly consists of Si, Al, Fe, Mg, and K, with minor amounts of Ca, Na, and Ti. Iron oxide grains may develop along spherulitic growth fronts during devitrification. New growth of Mg-rich clay minerals occurs in vugs between melt fragments of some samples. Mg-rich clay minerals in vugs are similar in composition to clay minerals replacing melt glass.

Apart from devitrification, the formation of secondary K-feldspar (adularia) is the most significant alteration observed in all impactites. In most cases irregular patches of anhedral K-feldspar are replacing parts of melt fragments. Poikilitic textures may occur when K-feldspar is only replacing the melt matrix and plagioclase microphenocrysts or other minerals are preserved. Subhedral to euhedral K-feldspar is a common vug-filling mineral. The occurrence of secondary K-feldspar in breccia dikes in the sediments (megablock) indicates that potassic alteration is not restricted to the suevite-type breccia unit and suggests that both lithological units underwent the same hydrothermal event.

Although calcite is a “primary” component of the impact breccia unit (carbonate melt or carbonate rock fragments), there are many indications of calcite mobilization and/or recrystallization. In paragenesis with secondary K-feldspar calcite is filling vugs in the impactites and in the sediments. Newly formed calcite is also replacing the primary matrix of the impactites. Secondary calcite is locally associated with small grains of Sr-rich baryte. Dolomite may be replaced by calcite in the altered sediments. Pyrite occurs in the altered suevitic dikes and in altered parts of the sediments close to the dikes. Intergrowths of pyrite and K-feldspar suggest that they are contemporaneous. Fluorite and anhydrite have also been observed as secondary hydrothermal minerals in the altered sediments. The exact timing of secondary fluorite and anhydrite, however, is not yet clear. Corrosion of quartz may occur during stage 1.

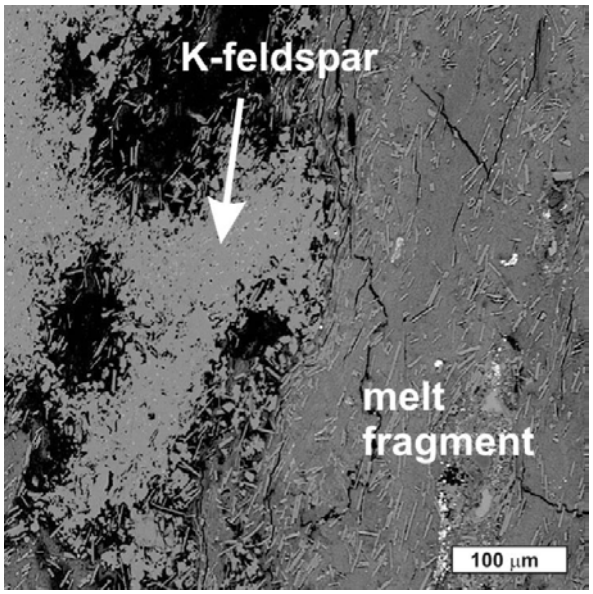

Fig. 1: BSE image of melt fragments partly replaced by secondary K-feldspar (adularia). "Upper Suevite" (see [1]) of Yax-1 (depth 824.01 m).

Stage 2) A late stage characterized by the formation of vug-filling chalcedony and albite has been observed in the altered suevitic dikes and in the adjacent sediments. Secondary albite within the impact melt lithologies, however, is rare.

Whole rock chemistry. In total 30 samples of the impactites have been analyzed for major and some trace element contents by XRF. The samples are rather heterogeneous and altered samples can not easily be referred to an unaltered equivalent. Therefore precise mass balance calculations are almost impossible. Strong variations in SiO_2 (7 to 55 wt. %) and CaO (6 to 48 wt.%) of the impact melt rocks (Fig. 2) are mainly due to varying mixtures of the two major target lithologies, crystalline basement of bulk granodioritic composition and carbonate rocks [1]. This also effects the K_2O contents which vary between about 1 and 7 wt.%.

The impact breccias at Yax-1 show much higher K_2O contents at constant SiO_2 compared to the Y6 and C1 drill sites (Fig. 2). We can not rule out that part of the difference in chemical composition between the impactites from Yax-1 and Y6 + C1 are due to compositional variations in the target lithologies of the basement. But we suggest that the high K_2O contents at Yax-1 are due to the formation of secondary K-feldspar. This can be demonstrated by plotting the K_2O/Na_2O ratio which is not effected by mixing silicate basement rocks with carbonate sediments. On average the K_2O/Na_2O is significantly above 0.8 for impactites of Yax-1 and below 0.8 for impactites of Y6 and C1.

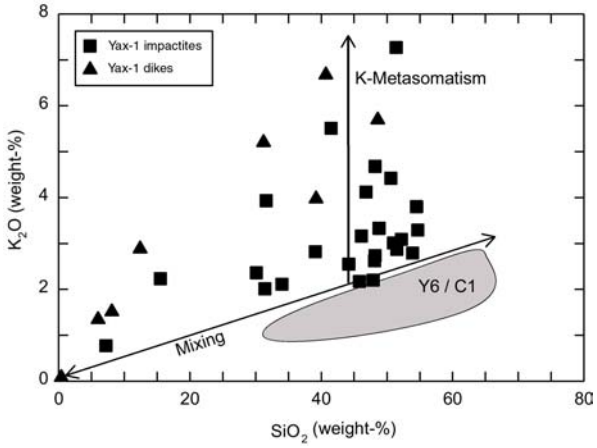

Fig. 2: K_2O vs SiO_2 of impactites from the Chicxulub crater (Yax-1). Samples from Y6 and C1 are plotted for comparison (data from [3,4])

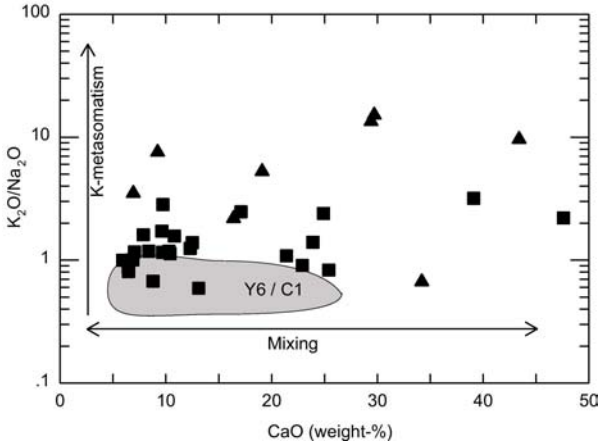

Fig. 3: K_2O/Na_2O vs CaO of impactites from the Chicxulub crater (Yax-1). Legend and data see Fig. 2.

Highest K_2O/Na_2O are shown in the lowermost impact breccias ("Lower Suevite") and in the suevitic dike breccias (Fig. 4). The "Lower Suevite" (LS) is also characterized by intensive formation of secondary K-feldspar. Some melt fragments in this unit are almost completely overgrown or replaced by K-feldspar. This clearly indicates that the high K_2O/Na_2O ratios at Yax-1 are not a primary feature of the impact melt but are caused by secondary K-feldspar growth.

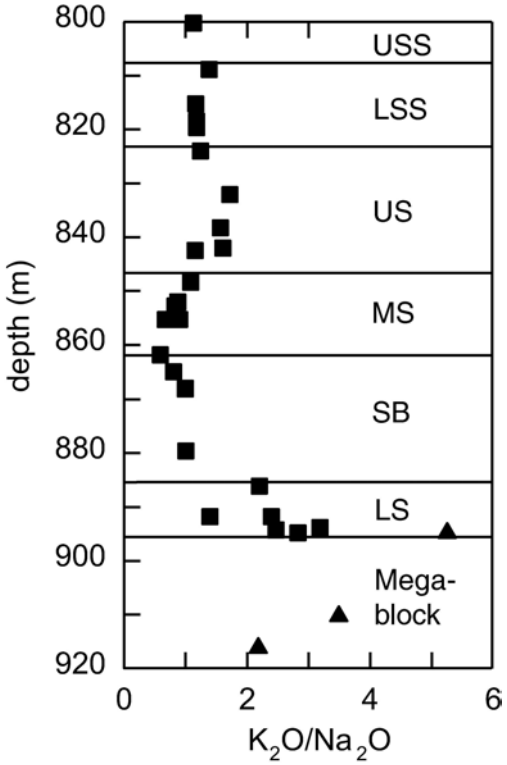

Fig. 4 K_2O/Na_2O vs depth of impactites at Yax-1. Legend of symbols see Fig. 2. Legend of impact breccia units according to [1]: USS=Upper sorted suevite, LSS=Lower sorted suevite, US=Upper suevite, MS=Middle suevite, SB=Suevitic breccia, LS=Lower suevite.

Conclusions. Petrography and whole rock chemical data of impactites from Yax-1 show open system hydrothermal alteration. Most evident is the supply of potassium causing the formation of secondary K-feldspar. Alteration has also effected some trace elements like Ba and Sr (formation of baryte). Therefore extreme caution should be taken when impactites from Yax-1 are used for the reconstruction of the target lithologies involved in the melting process. This holds also for the application of radiogenic isotopes (e.g. the Rb/Sr system).

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References. [1] Stöffler et al. (2003), this volume. [2] Wittmann et al. (2003), this volume. [3] Schuraytz P.H. et al., Geology **22**, 868-872. [4] Heuschkel, S. and Claeys, P., unpublished data.